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## STEM education with Unity 3D

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#### How to cite:

Minocha, Shailey and Burden, David (2013). STEM education with Unity 3D. In: Virtual Worlds Education Roundtable (VWER), 11 Jul 2013, Second Life (3D virtual world).

For guidance on citations see [FAQs](#).

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Version: Version of Record

Link(s) to article on publisher's website:

<http://www.vwer.org/2013/07/11/july-11-2013-shailey-minocha-on-stem-education-with-unity-3d/>

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The Open University

# STEM Education with Unity 3D

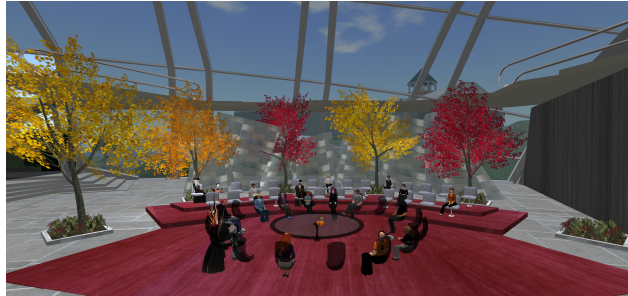
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The Open University, UK and Daden Limited



## Projects in Second Life

- socialisation
- team working in distributed teams
- design of 3D learning spaces
- navigation and wayfinding in 3D learning spaces

## Institutional perspective



- software not owned by us
- control
- availability
- not perceived for education alone

## 3D virtual environment and a Field trip



- scope to demonstrate interactivity
- realism and high degree of fidelity
- visual and spatial experience not constrained by a 'flat' 2D user interface, sense of being there
- helps internalise the sense of exploration

## Field trips in our institution



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- real field trips two or three times a year (tutor-led)
- DVD to facilitate reflection and activities
- DVD also helpful for students who are unable to go for real field trips

## Lake District in the UK



- Skiddaw field area
- 6 sites
- Skiddaw group of rocks: sandstone, slates, granite
- Geological significance
  - how **metamorphism** varies in the Skiddaw group sedimentary rocks due to the intrusion of the Skiddaw granite
  - how the Skiddaw group rocks **deformed** during the mountain-building event



## Realism: Virtual Geology Field trip



- Realism
  - design of the environment or landscape
    - LIDaR data
    - Photogrammetry data
    - 3D modeling to weave it together
  - learning activities (similar to a real field trip)
    - choosing the equipment, learning to use the compass, sketching rocks

## Video Part 1 (what to look for?)



- audio and textual guidance (tutor-led)
  - introduction
  - Geology of the area
  - instructions for learning activities
- choice of avatars
- choosing equipment for the field trip
- list of learning activities
- using the compass, sketch points and sketching
- [http://www.youtube.com/watch?v=5\\_h4NI3AvCY](http://www.youtube.com/watch?v=5_h4NI3AvCY)

## Realism: Virtual Geology Fieldtrip

- Realism: multi-user or multi-avatar environment
  - tutor-led
  - group exploration
  - whose online and where?
  - text chat
  - settings to control the multi-user functionality

## Non-realism: 3D Virtual Geology Field Trip

- Non-realism (things you can't do in a real field trip)
  - microscopic views of rocks within the environment
  - draping maps on the landscape
  - cutaways into the mountainside to see the geology underneath

## Video Part 2 (what to look for?)

- student investigates grain composition of one rock
- overlaying maps on the landscape
  - ordnance survey map
  - Geology map
- cross-section of the mountains
  - showing the rocks (geology) underneath
- different views in each of the contexts
  - overhead, North-East, North-West, etc.
- <http://www.youtube.com/watch?v=MOdu5jQukUk>

## Opportunities for students and educators

- practice/training for real life field trips
- reflect on your experiences of real field trips
- fly across the landscape
- additional field trip to a real field trip
- could replace a real field trip if resources are limited

## Limitations: student learning and experiences



- risk awareness skills
- challenges of being outdoors
- challenges posed by the weather
- challenges of using the equipment in real life
- bonding with other students

## Challenges of 3D virtual field trips



- costs involved in design, development and evaluation
- multi-skilled team and specialist developers are required
- student training
- overcoming the (negative) perceptions that people have about virtual field trips
- how best to communicate that virtual field trips are not being proposed to replace real field trips

## Why Unity



### ■ Pros:

- Browser based deployment (with plug-in)
- Complete control over client and server (cf Second Life/OpenSim)
- Support for large areas and high detail meshes
- Allows 2D and 3D learning segments
- Fully robust and stable
- iPad deployment

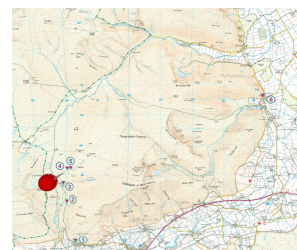
### ■ Cons:

- No in-built avatar capability
- No in-built multi-user capability
- You need to build EVERYTHING

## Wide Area Model



- 10km x 10km = 1600 sims!
- Digital Elevation Model derived from airborne radar database
- Terrain imagery derived from aerial survey, c.1-5 m detail
- Cleaned in Blender/3D Studio Max and imported into Unity
- Walk, fly or teleport navigation (with compass & minimap)



## Site Models



- 6 sites, typically 50m x 50m, c.2-10 cm detail
- Photogrammetry derived mesh and texture imagery
- Cleaned in Blender/3D Studio Max and imported into Unity
- 6 individual rocks, again photogrammetry scanned to c.1-5 mm detail
- Augment with in-built Unity terrain and flora
- 1 rock has more data than 1 site, 1 site has more data than whole 100 sq km



## Avatars



- No standard avatar, animation or clothing model (Unity4 now has standard animations)
- Third party avatars have different skeletons, need different animations,
- No common look & feel (and often very "gamey")
- Clothes typically integral to the mesh, so SL style wardrobe/skin/hair layers



## Multi-User



- No in-built functionality in Unity3D, wrote it all ourselves
- Played with Jibe but settled on PhotonServer as it gave us finer control and was more generic
- Cloud or locally hosted reflection server to manage multi-user comms
- “on-line/where is” list, chat, and “visibility fader”
- Hybrid mode – you can see other users, they can see you, but you don’t see their changes to the environment – ideal for fieldwork type activities (eg picking up rocks, changing map layers etc)
- Future options to create a “tutor” mode with god powers over other avatars, and instances/shards so each class can have own version of the environments



## iPad version



- Demonstration only at moment – only one site
- No keyboard/mouse so slightly different UI
- Virtual joystick for avatar movement
- Very limited memory given size of meshes and textures
- Feels far more tactile/engaging, and iPad screen size adequate



# Summary



- What we've liked:
  - Having complete control of the environment
  - Building a multi-user environment with only the functionality you need for an educational task
  - Running through a browser and on an iPad
  - The site visit (see right!)
  - Working with the OU team!
  
- What we've not liked (so much)
  - Having to build EVERYTHING
  - No standard avatars and animation
  - Matching 3 different terrain modelling techniques

